

**EE 331 – Microprocessor Hardware and Software**

Instructor: Seok-Bum Ko, Duration: 2 hours

- Open Book Only exam. Except calculator, no homework solutions.
- Use one page of your examination booklet for each question in this exam.
- No interaction with another student is allowed during the exam. Cheating will not be tolerated.

2. In an audio CD, the audio voltage signal is typically sampled about 44,000 times per second, and the value of each sample is recorded on the CD surface as a binary number. In other words, each recorded binary number represents a single voltage point on the audio signal waveform.
- ✗ If the binary numbers are six bits in length, how many different voltage values can be represented by a single binary number? (1 point)
 - ✗ If ten-bit numbers are used, how many bits will be recorded on the CD in 1 second? (2 points)
 - ✗ If a CD can typically store 5 billion bits, how many seconds of audio can be recorded when ten-bit numbers are used? (2 points)

3. Refer the following program and answer the questions:
Assume that the following operands are initially stored in data memory:
[C350] = 08; [C351] = 06; [C352] = FF.
- ✗ What will be [A] and [C352] at the completion of the program? (3 points)
 - ✗ Assume that [C351] = 08 initially and repeat Part a. (3 points)

Memory address	Memory word
C300	B6
C301	C3
C302	50
C303	B0
C304	C3
C305	51
C306	27
C307	03
C308	B7
C309	C3
C30A	52
C30B	3E
C30C	??

4. Modify the logic of Figure 5.23 (p. 235) to include four more pages of RAM (pages 04-07). Provide the modification to 74HC138. (Hint: It requires more modification than simply using the other four decoder outputs.) (5 points)
5. Show the stack contents and stack pointer for the following instruction sequence. Initially stack pointer contains \$0900. PSHA, PSHX, PULX, PULA (7 points). The stack pointer register in 68HC11 is a 16-bit register. There are some 8-bit microprocessors on the market that have an 8-bit stack pointer register. State the major advantage that a 16-bit stack pointer register offers over an 8-bit register. (3 points)

6. The following instruction sequence is a time-delay subroutine that produces an approximate delay of $1\text{ms} \times [X]$.
Calculate the exact delay for the delay subroutine for $[X] = 01$ (5 points).
Repeat for $[X] = 05$ (5 points).

C800	START	LDY #\$011C
C804	LOOP	DEY
C806		BNE \$C804
C808		DEX
C809		BNE \$C800
C80B	RETURN	RTS

7. Refer to the incomplete external RAM decoding circuit of Figure 8. 20 (P. 448). The 256×4 RAM memory module is to be selected whenever the range of addresses \$C300 - \$C3FF is present on the address bus of the 68HC11. Show how to decode the address bus using the decoder shown and any other logic gates you may need. Also, connect the required signals to the RAM memory module. (7 points)
8. Modify the circuit of Figure 9. 14 (P. 470) so that address 3001 is used to access the UART's control and status registers, and address 3000 is used to access RxDR and TxDR. (7 points)

THE END